Quasi-free scattering from relativistic neutron-deficient carbon isotopes*

M. Holl[1] *and the R*^{3}*B Collaboration*

[1]Institut für Kernphysik, Technische Universität Darmstadt, Germany

The R^{3}B-collaboration conducted an experiment studying quasi-free scattering from light nuclei in a wide A/Z range in August 2010 [1]. Among others, the neutron-deficient carbon isotope ^{11}C was investigated. The study was aimed at determining single-particle properties of nuclei with a focus on a quantitative understanding of absolute spectroscopic factors for which a strong quenching for deeply bound nucleons has been shown in single-nucleon knockout reactions [2].
In this experiment, a ^{40}Ar primary beam was incident on a production target, and the reaction residues of interest were selected and transported to the R^{3}B-LAND setup in Cave C using the fragment separator FRS. The incoming beam was identified using the time-of-flight between two scintillators, one at focus S8 of the FRS and one at the entrance of Cave C, and the energy loss in a PIN diode. The incoming angle of the beam was determined from the position on two silicon strip detectors in front of the target.

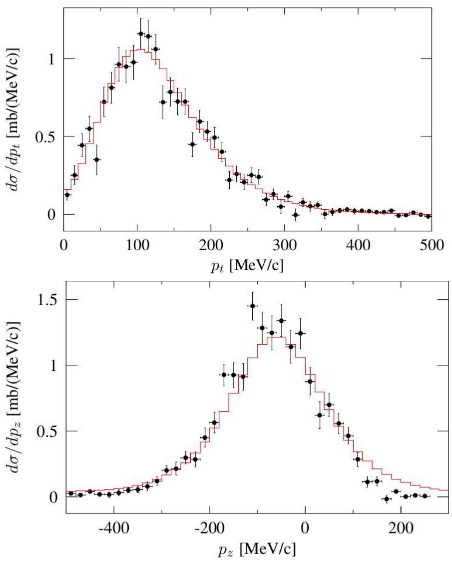

Figure 1: Transversal and longitudinal momentum of ^{10}B fragments measured in coincidence with two protons in the Crystal Ball NaI array. The experimental distributions are compared to results of DWIA calculations [3].

The target area was surrounded by the Crystal Ball NaI-array used for γ and proton detection and a box consisting of four silicon strip detectors. After passing through the ALADIN magnet, the charge, mass, and total momentum of the outgoing fragments were reconstructed using the

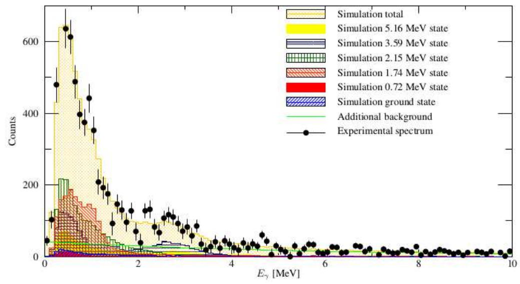

Figure 2: Gamma energy spectrum measured in coincidence with the ^{11}C(p,2p)^{10}B reaction.

position and energy information given by two additional silicon strip detectors, two fiber detectors, and a time-of-flight wall.
Measurements were done using a CH_2 target, and background measurements using a carbon target were used to obtain the cross section on hydrogen. The resulting cross section is $\sigma = 17.3(8)$ mb which corresponds to a spectroscopic factor of $C^2S = 2.16(10)$.
In Fig. 1 the transversal and longitudinal momentum distributions of ^{10}B nuclei measured in coincidence with two protons in the Crystal Ball NaI-array are shown. They are compared to results of DWIA calculations [3] which were made under the assumption of a knockout from the $p_{3/2}$-shell and show good agreement.

Figure 2 shows the γ-energy spectrum measured in coincidence with the ^{11}C(p,2p)^{10}B reaction. The population of excited states was determined by fitting simulated responses to single excited states obtained using the R3BRoot framework [4] to the experimental spectrum. It is clear that the overall population of excited states is high ($\approx 50\%$). A strong population of the low-lying excited states is observed, indicating a strong contribution of particle-hole states to the ground state of ^{11}C. This is also in agreement with the observation of large cross sections for the population of low-lying unbound states.

References

[1] T. Aumann et al., 'Direct Reactions of light exotic beams measured in complete kinematics at R3B', GSI Scientific Report 2010, p.166,

[2] A. Gade et al., Phys. Rev. C 77(4) 044306 (2008)

[3] T. Aumann, C. A. Bertulani, and J. Ryckebusch, Phys. Rev. C 88 064610 (2013).

[4] D. Bertini, J. Phys. Conf. Ser., 331 0322036 (2011).

* Supported by the State of Hesse (LOEWE Centre HIC for FAIR), and through the GSI-TU Darmstadt cooperation agreement.

 DOI:10.15120/GR-2015-1-MU-NUSTAR-NR-04